March 13, 2008

To: Joseph P. Hirl
From: Kermit D. Lopez
Re: 10/735,934; Docket No. 1000-1207

Follow up -- Re: proposed changes leading to allowance

We are following up re: your recent telephone call re: U.S. Patent Application Serial. No. 10/735,934 (our docket # 1000-1207). We propose a set of claim amendments (see below) that are consistent with our discussion, along with a few minor changes/amendments to correct antecedent basis and consistency in claim language. We are proposing amendments to claims to provide for the feedback circuit. This feature was a "feedback mechanism" in claim 32. We propose cancelling claim 32 and incorporating this feature as a feedback circuit in the independent claims. We also propose minor amendments to claims 33 and 41 for consistency purposes.

Additionally, we do not see any 102/103 issues concerning USPN 6,536,106 (Jackson). The Jackson reference concerns using dielectrophoresis (DEP) to align things on a chip, as a fabrication process. Applicant uses DEP as an integral part of an active device, which of course must include feedback. Jackson is patenting an assembly process. Applicant is patenting an "active" electronic device. "active" is in quotes because it adapts but does not amplify. So, Jackson is using DEP as a means to an end...a final particle assembly or placement. Applicant uses it as the means in and of itself...i.e., DEP (with applied feedback) forms a dynamic system that results in a continuously adaptive device. Additionally, there is no teaching by Jackson of neural networks, synapses, etc.

We are agreeable to an Examiner's amendment to make these changes leading to an allowance. If you have any other questions or concerns, please let me know.

PROPOSED CLAIM AMENDMENTS

Amend claims 24, 33, 40, 41 and 42 and cancel claim 32 as follows:

Claims 1-23 (Previously Cancelled)

24. (Currently Amended) An electromechanical neural network system based on nanotechnology, comprising:

an adaptive synaptic element comprising a plurality of nanoconductors suspended and free to move about in a liquid dielectric solution located within a connection gap formed between at least one pre-synaptic electrode and at least one post-synaptic electrode, wherein said liquid dielectric solution comprises a mixture of said plurality of nanoconductors and a dielectric solvent, wherein said liquid dielectric solution possesses an electrical conductance that is less than an electrical conductance of said plurality of nanoconductors suspended in said liquid dielectric solution;

a plurality of interconnected nanoconnections associated with said adaptive synaptic element, said plurality of interconnected nanoconnections comprising said plurality of nanoconductors in said liquid dielectric solution, said plurality of interconnected nanoconnections electrically connecting said at least one pre-synaptic electrode to said at least one post-synaptic electrode through said liquid dielectric solution and said plurality of nanoconductors disposed within said liquid dielectric solution; and

a voltage mechanism for applying an electric field across said connection gap, whereby said electric field induces a dipole in each nanoconductor among said plurality of nanoconductors, thereby creating a dielectrophoretic force attracting said plurality of nanoconductors to said connection gap and aligning said plurality of nanoconductors within said liquid dielectric solution and strengthening or weakening each nanoconnection among said plurality of interconnected nanoconnections according to an application of said electric field across said connection gap; and

a feedback circuit electrically connected to and associated with said adaptive synaptic element and said voltage mechanism, said feedback circuit providing at least one feedback signal, wherein said feedback circuit together with said adaptive synaptic element and said voltage mechanism comprise a multi-layer, feed-forward network that includes said liquid dielectric solution, said at least one pre-synaptic electrode and said at least one-post synaptic electrode.

25. (Original) The system of claim 24 further comprising:

a plurality of synapses associated with said adaptive synaptic element, wherein said plurality of synapses comprises said plurality of interconnected nanoconnections of said adaptive synaptic element and wherein each synapse among said plurality of synapse adapts to a voltage independent of voltage polarization.

26. (Original) The system of claim 24 wherein each nanoconductor among said plurality of nanoconductors comprises a carbon nanotube.

27. (Original) The system of claim 24 wherein each nanoconductor among said plurality of nanoconductors comprises gold.

28. (Original) The system of claim 24 wherein each nanoconductor among said plurality of nanoconductors comprises latex.

29. (Original) The system of claim 24 wherein each nanoconductor among said plurality of nanoconductors comprises DNA.

30. (Original) The system of claim 24 wherein each nanoconductor among said plurality of nanoconductors comprises silicon.

31. (Original) The system of claim 25 wherein said voltage mechanism for applying an electric field across said connection gap applies a voltage across a space occupied by said liquid dielectric solution to configure and arrange said adaptive synaptic element, said voltage comprising a DC voltage or an AC voltage that when applied across said liquid dielectric solution gradually forms said interconnected nanoconnections of said plurality of interconnected nanoconnections in said liquid dielectric solution within said connection gap between said at least one pre-synaptic electrode and said at least one post-synaptic electrode.

32. (Cancelled)

33. (Original) The system of claim 24 wherein said ~~further comprising a~~ feedback circuit connected to ~~mechanism connection to~~ said adaptive synaptic element ~~that~~ provides for a Hebbian synapse modification that permits said adaptive synaptic element to function as a recurrent and highly interconnected network.

34. (Original) The system of claim 24 further comprising a learning mechanism connected to said adaptive synaptic element to train said electromechanical neural network system, wherein said learning mechanism trains said electromechanical physical neural network utilizing an STDP (Spike-Timing Dependent-Plasticity) training rule.

35. (Original) The system of claim 31 wherein said voltage mechanism generates a weak alternating electric current perpendicular to said plurality of interconnected nanoconnections, which causes at least some of said plurality of interconnected nanoconnections not contributing to a desired output to weaken and eventually dissolve back into said liquid dielectric solution, thereby allowing for an increased flexibility in a continuous training of said electromechanical neural network system utilizing said training mechanism.

36. (Original) The system of claim 34 wherein at least some of said interconnected nanoconnections among said plurality of interconnected nanoconnections are weakened by increasing a temperature of said liquid dielectric solution, which causes at least some of said plurality of interconnected nanoconnections not contributing to a desired output to weaken and eventually dissolve back into said liquid dielectric solution, thereby allowing for an increased flexibility in a continuous training of said electromechanical neural network system utilizing said training mechanism.

37. (Original) The system of claim 25 further comprising:

at least one base neuron in a perpendicular array structure composed of a plurality of neural network layers coupled with said plurality of synapses comprising said plurality of interconnected nanoconnections of said adaptive synaptic element, wherein each synapse among said plurality of synapses comprises a plurality of connections conduits separated by a particular distance wherein each connection conduit among said plurality of connection conduits is a result of said plurality of nanoconductors aligning in the presence of said electric field, wherein said electric field is generated by a temporal and sequential firing of said at least one base neuron.

38. (Original) The system of claim 24 wherein said dielectric solvent comprises a volatile liquid and further comprising an air-tight seal for confining said liquid dielectric solution within said connection gap to prevent said volatile liquid from coming into contact with air.

39. (Original) The system of claim 25 further comprising a gate located adjacent said connection gap, and insulated from electrical contact by an insulation layer, wherein said gate is connected to logic circuitry which can activate or deactivate at least one synapse among said plurality of synapses utilizing a gate voltage provided by said gate, whereby a resistance between said at least one pre-synaptic electrode and said at least one post-synaptic electrode is modifiable by aligning said plurality of nanoconductors in said liquid dielectric solution when said electric field is applied across said connection gap and comprises an alternating electric field.

40. (Currently Amended) An electromechanical neural network system based on nanotechnology, comprising:

a resistive synaptic element comprising a plurality of nanoconductors suspended and free to move about in a liquid dielectric solution located within a connection gap formed between at least one pre-synaptic electrode and at least one post-synaptic electrode, wherein said liquid dielectric solution comprises a mixture of said plurality of nanoconductors and a dielectric solvent, wherein said resistive synaptic element functions as an impermanent interconnect between said at least one pre-synaptic electrode and said at least one post-synaptic electrode;

a plurality of interconnected nanoconnections associated with said resistive synaptic element, said plurality of interconnected nanoconnections comprising said plurality of nanoconductors in said liquid dielectric solution, said plurality of interconnected nanoconnections electrically connecting said at least one pre-synaptic electrode to said at least one post-synaptic electrode through said liquid dielectric solution and said plurality of nanoconductors disposed within said liquid dielectric solution;

a plurality of synapses associated with said resistive synaptic element, wherein said plurality of synapses comprises said plurality of interconnected nanoconnections of said resistive synaptic element and wherein each synapse among said plurality of synapses is independent of voltage polarization; and

a voltage mechanism for applying an AC electric field across said connection gap, whereby said AC electric field induces a dipole in each nanoconductor among said plurality of nanoconductors only when said plurality of nanoconductors is located within said liquid dielectric solution, thereby generating a dielectrophoretic force attracting said plurality of

nanoconductors to said connection gap and aligning said plurality of nanoconductors within said liquid dielectric solution and strengthening or weakening each nanoconnection among said plurality of interconnected nanoconnections according to an application of said AC electric field across said connection gap so that said electromechanical neural network system adapts itself to the requirements of a given situation regardless of the initial state of said plurality of interconnected nanoconnections; and

a feedback circuit connected to and associated with said resistive synaptic element and said voltage mechanism, said feedback circuit providing at least one feedback signal, wherein the longer the amount of time said AC electric field is applied across said connection gap and/or the greater the frequency or amplitude of said AC electric field applied across said connection gap, the more nanoconductors among said plurality of nanoconductors align and the stronger said interconnected nanoconnections among said plurality of nanoconnections become.[.]

41. (Currently Amended) The system of claim 40 further comprising a learning mechanism connected to said resistive synaptic element to train said electromechanical neural network system, wherein said learning mechanism includes said feedback circuit and trains said electromechanical physical neural network utilizing an STDP (Spike-Timing Dependent-Plasticity) training rule.

42. (Currently Amended) A method of forming an electromechanical neural network system based on nanotechnology, comprising:

providing a liquid dielectric solution comprising a mixture of a dielectric solvent and a plurality of nanoconductors, wherein each nanoconductor among said plurality of nanoconductors is suspended and free to move about in said liquid dielectric solution;

forming a connection gap between at least one pre-synaptic electrode and said at lease post-synaptic electrode;

configuring a connection network to comprise said plurality of nanoconductors suspended and free to move about in said liquid dielectric solution located within said connection gap formed between said at least one pre-synaptic electrode and said at least one post-synaptic electrode, wherein said connection network comprises an impermanent interconnect between said at least one pre-synaptic electrode and said at least one post-synaptic electrode;

configuring said connection network to comprises a plurality of interconnected nanoconnections with said connection network, wherein said plurality of interconnected nanoconnections comprise said plurality of nanoconductors in said liquid dielectric solution, said plurality of interconnected nanoconnections electrically connecting said at least one pre-synaptic electrode to said at least one post-synaptic electrode through said liquid dielectric solution and said plurality of nanoconductors disposed within said liquid dielectric solution;

providing a plurality of synapses from said connection network, wherein said plurality of synapses comprises said plurality of interconnected nanoconnections of said connection network and wherein each synapse among said plurality of synapses is independent of voltage polarization; ~~and~~

applying an electric field across said connection gap, whereby said electric field induces a dipole in each nanoconductor among said plurality of nanoconductors only when said plurality of nanoconductors is located within said liquid dielectric solution, thereby generating a dielectrophoretic force attracting said plurality of nanoconductors to said connection gap and aligning said plurality of nanoconductors within said liquid dielectric solution and strengthening or weakening each nanoconnection among said plurality of interconnected nanoconnections according to an application of said electric field across said connection gap; and

providing at least one feedback signal to said connection network from a feedback circuit connected to and associated with said connection network and said plurality of synapses.

43. (Original) The method of claim 42 wherein the longer the amount of time said electric field is applied across said connection gap and/or the greater the frequency or amplitude of said electric field applied across said connection gap, the more nanoconductors among said plurality of nanoconductors align and the stronger said interconnected nanoconnections among said plurality of nanoconnections become.

44. (Original) The method of claim 42 further comprising training said electromechanical neural network system utilizing an STDP (Spike-Timing Dependent-Plasticity) training rule.